PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2001-280123
(43)Date of publication of application : 10.10.2001

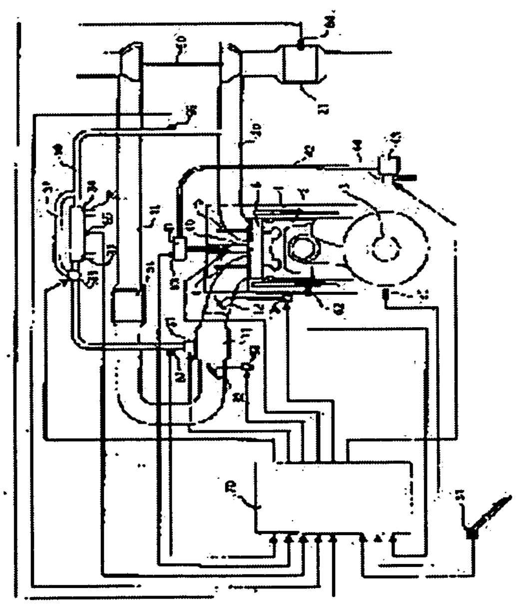
(51)Int.Cl.
F01N 3/24
F01N 3/20
F02D 21/08
F02D 41/04
F02D 41/14
F02D 41/40
F02D 43/00
F02D 45/00
F02M 25/07

(21)Application number : 2000-094654
(22)Date of filing : 30.03.2000

(71)Applicant : NISSAN MOTOR CO LTD
(72)Inventor : YOKOI TARO
NIIZAWA MOTOHIRO
MATSUMOTO YASUO

(54) INTERNAL COMBUSTION ENGINE

(57)Abstract:



PROBLEM TO BE SOLVED: To prevent the deterioration of exhaust emission caused when the activity of a catalyst is interfered by cooling the recirculated exhaust gas to increase the NOx reducing effect in an internal combustion engine provided with an exhaust recirculating circulating device.

SOLUTION: In this internal combustion engine having a EGR cooler 34 for adjusting a temperature of the exhaust gas flowing into an intake path 10 through a EGR path 30, a degree of the activity of the catalyst 21 is determined on the basis of its temperature and exhaust components, and a bypass path 37 formed in the EGT cooler 34 is opened for lowering the cooling efficiency of the EGR gas when the degree of the activation of the catalyst is low.

LEGAL STATUS

[Date of request for examination]

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

Japanese Publication number : 2001-280123 A

JPO and NCIPI are not responsible for any damages caused by the use of this translation.

1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3. In the drawings, any words are not translated.

CLAIMS

[Claim(s)]

[Claim 1] When it is in the exhaust air reflux path which connects an internal combustion engine's inhalation-of-air path and flueway, and the exhaust air reflux operating range to which the engine was set beforehand, The exhaust air reflux control means which makes a part of exhaust gas in said flueway flow back into said inhalation-of-air path through said exhaust air reflux path, A reflux exhaust gas temperature accommodation means to adjust the temperature of the exhaust gas which flows into an inhalation-of-air path through said exhaust air reflux path, The catalyst for exhaust gas purification infixed in said flueway, and a catalytic activity degree detection means to detect the activity degree of said catalyst, The exhaust gas temperature control means which controls the temperature of exhaust gas by said reflux exhaust gas temperature accommodation means according to the activity degree of said detected catalyst so that the temperature of the exhaust gas which flows into an inhalation-of-air path from an exhaust air reflux path rises when the activity degree of a catalyst is lower than a predetermined activity degree, Preparation **********.

[Claim 2] When it is in the exhaust air reflux path which connects an internal combustion engine's inhalation-of-air path and flueway, and the exhaust air reflux operating range to which the engine was set beforehand, When it is in the exhaust air reflux control means which makes a part of exhaust gas in said flueway flow back into said inhalation-of-air path through said exhaust air reflux path, and the predetermined operating range by which the engine was beforehand set up in said exhaust air reflux operating range, When fuel injection is made to perform at predetermined fuel injection timing when the ignition-delay period of an injection fuel is long and an engine's service condition is out of said predetermined operating range, In the compression ignition type internal combustion engine with which the ignition-delay period of an injection fuel equips short predetermined fuel injection timing with the fuel-injection control means to which fuel injection is made to carry out A reflux exhaust gas temperature accommodation means to adjust the temperature of the exhaust gas which flows into an inhalation-of-air path through said exhaust air reflux path, The catalyst for exhaust gas purification infixed in said flueway, and a catalytic activity degree detection means to detect the activity degree of said catalyst, It has the reflux exhaust gas temperature control means which controls the temperature of exhaust gas by said reflux exhaust gas temperature accommodation means so that the temperature of exhaust gas rises, when the activity degree of said detected catalyst is

lower than a predetermined activity degree. The internal combustion engine which constituted so that at least one side of the control which shortens the control or the fuel fuel injection period which an engine is in said predetermined operating range about said fuel-injection control means, and lengthens the ignition-delay period of an injection fuel at the time of the reflux exhaust gas temperature rise by the reflux exhaust gas temperature control means might be performed.
[Claim 3] The internal combustion engine having the inhalation-of-air flow control valve which controls an inhalation-of-air flow of an engine combustion chamber, and the inhalation-of-air flow control means which controls said inhalation-of-air flow control valve in the direction in which an inhalation-of-air flow increases at the time of said reflux exhaust gas temperature rise according to claim 2.
[Claim 4] Said catalytic activity degree detection means is an internal combustion engine according to claim 1 or 2 which detects the activity degree of a catalyst based on the temperature of a catalyst.
[Claim 5] Said catalytic activity degree detection means is an internal combustion engine according to claim 1 or 2 which detects the activity degree of the catalyst for exhaust gas purification based on the temperature and the degradation degree of a catalyst.
[Claim 6] Said catalytic activity degree detection means is an internal combustion engine according to claim 1 or 2 which detects the purified matter concentration of a catalyst lower stream of a river, and detects the activity degree of a catalyst based on this purified matter concentration.
[Claim 7] Said reflux exhaust gas temperature accommodation means is an internal combustion engine given in any of claim 1 equipped with a reflux exhaust gas cooling means to cool the exhaust gas which circulates the inside of an exhaust air reflux path, and a reflux exhaust gas cooling effectiveness accommodation means to adjust the cooling effectiveness of the exhaust gas by this reflux exhaust gas cooling means, or claim 2 they are.
[Claim 8] Said reflux exhaust gas cooling effectiveness accommodation means is an internal combustion engine having the by-pass control valve which controls the opening of the bypass path which bypasses a reflux exhaust gas cooling means and passes reflux exhaust gas, and this bypass path according to claim 7.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to amelioration of the internal combustion engine having exhaust air reflux equipment.
[0002]
[Description of the Prior Art] It is effective to reduce combustion temperature to reduce NOx discharged by the internal combustion engine, and, generally the exhaust gas reflux

control (EGR control) which makes a part of exhaust gas flow back to an inhalation-of-air path as a means to reduce combustion temperature is used. Since the fall effectiveness of combustion temperature will become large if the exhaust gas which flows back to an inhalation-of-air path is cooled, there is also a thing he is trying to cool reflux exhaust gas using engine cooling water like the exhaust air reflux equipment indicated by JP,8-261072,A.

[0003] By the way, in the exhaust gas discharged by the internal combustion engine, the unburnt fuel component (HC) other than NOx is contained, and the current mainstream arranges and processes to a flueway the catalyst which supported noble metals as a means which carries out purification processing of this. Since this catalyst has the property of demonstrating purification capacity above a certain activity temperature, it becomes important [that a catalyst is always maintained beyond activity temperature].

[0004] However, since the temperature of the exhaust gas which flows into the part catalyst will also fall when a lot of exhaust gas for NOx reduction is made to flow back and combustion temperature is reduced, time amount after putting an engine into operation until a catalyst reaches activity temperature may become long, or when low load driving continues for a long time, the temperature of a catalyst may become lower than activity temperature. At the thing he is trying to cool especially reflux exhaust gas, the inclination is large, in a compression ignition type engine with low, exhaust gas temperature still more from the first, such a problem becomes remarkable and there is a possibility of worsening the exhaust air purification engine performance by the catalyst.

[0005] This invention was made paying attention to such a trouble, and aims at improving the exhaust air emission engine performance by adjusting the temperature of reflux exhaust air according to the activity degree of a catalyst.

[0006]

[Means for Solving the Problem] When the exhaust air reflux path which connects an internal combustion engine's inhalation-of-air path and flueway, and the exhaust air reflux operating range to which the engine was set beforehand have the 1st invention, The exhaust air reflux control means which makes a part of exhaust gas in said flueway flow back into said inhalation-of-air path through said exhaust air reflux path, A reflux exhaust gas temperature accommodation means to adjust the temperature of the exhaust gas which flows into an inhalation-of-air path through said exhaust air reflux path, The catalyst for exhaust gas purification infixed in said flueway, and a catalytic activity degree detection means to detect the activity degree of said catalyst, According to the activity degree of said detected catalyst, when the activity degree of a catalyst is lower than a predetermined activity degree, it has the exhaust gas temperature control means which controls the temperature of exhaust gas by said reflux exhaust gas temperature accommodation means so that the temperature of the exhaust gas which flows into an inhalation-of-air path from an exhaust air reflux path rises.

[0007] When the exhaust air reflux path which connects an internal combustion engine's inhalation-of-air path and flueway, and the exhaust air reflux operating range to which the

engine was set beforehand have the 2nd invention, When it is in the exhaust air reflux control means which makes a part of exhaust gas in said flueway flow back into said inhalation-of-air path through said exhaust air reflux path, and the predetermined operating range by which the engine was beforehand set up in said exhaust air reflux operating range, When fuel injection is made to perform at predetermined fuel injection timing when the ignition-delay period of an injection fuel is long and an engine's service condition is out of said predetermined operating range, In the compression ignition type internal combustion engine with which the ignition-delay period of an injection fuel equips short predetermined fuel injection timing with the fuel-injection control means to which fuel injection is made to carry out A reflux exhaust gas temperature accommodation means to adjust the temperature of the exhaust gas which flows into an inhalation-of-air path through said exhaust air reflux path, The catalyst for exhaust gas purification infixed in said flueway, and a catalytic activity degree detection means to detect the activity degree of said catalyst, It has the reflux exhaust gas temperature control means which controls the temperature of exhaust gas by said reflux exhaust gas temperature accommodation means so that the temperature of exhaust gas rises, when the activity degree of said detected catalyst is lower than a predetermined activity degree. It constituted so that at least one side of the control which shortens the control or the fuel fuel injection period which an engine is in said predetermined operating range about said fuel-injection control means, and lengthens the ignition-delay period of an injection fuel at the time of the reflux exhaust gas temperature rise by the reflux exhaust gas temperature control means might be performed.

[0008] The 3rd invention is equipped with the inhalation-of-air flow control valve which controls an inhalation-of-air flow of an engine combustion chamber, and the inhalation-of-air flow control means which controls said inhalation-of-air flow control valve in the direction in which an inhalation-of-air flow increases at the time of a reflux exhaust gas temperature rise in the 2nd above-mentioned invention.

[0009] The 4th invention constitutes the catalytic activity degree detection means of the above 1st or the 2nd invention so that the activity degree of the catalyst for exhaust gas purification may be detected based on the temperature of a catalyst.

[0010] The 5th invention constitutes the catalytic activity degree detection means of the above 1st or the 2nd invention so that the activity degree of the catalyst for exhaust gas purification may be detected based on the temperature and the degradation degree of a catalyst.

[0011] The 6th invention is constituted so that the purified matter concentration of a catalyst lower stream of a river may be detected for the catalytic activity degree detection means of the above 1st or the 2nd invention and the activity degree of a catalyst may be detected based on this purified matter concentration.

[0012] The 7th invention is constituted as a thing equipped with a reflux exhaust gas cooling means to cool the exhaust gas which circulates the inside of an exhaust air reflux path in the reflux exhaust gas temperature accommodation means of the above 1st or the

2nd invention, and a reflux exhaust gas cooling effectiveness accommodation means to adjust the cooling effectiveness of the exhaust gas by this reflux exhaust gas cooling means.
[0013] The 8th invention is constituted as a thing equipped with the by-pass control valve which controls the opening of the bypass path which bypasses a reflux exhaust gas cooling means for the reflux exhaust gas cooling effectiveness accommodation means of invention of the above 7th, and passes reflux exhaust gas, and this bypass path.
[0014]
[Function and Effect] In each invention below invention of the above 1st, when the activity degree of a catalyst is low, the temperature of the exhaust gas which flows into an inhalation-of-air path from an exhaust air reflux path with a reflux exhaust gas temperature accommodation means is raised rather than the time of catalytic activity. For this reason, the conversion efficiency of a catalyst is raised promptly and it becomes possible to secure the necessary exhaust air purification engine performance.
[0015] When the 2nd invention has an engine in the predetermined operating range (henceforth a "premixed combustion operating range") beforehand set up in an exhaust air reflux operating range, Fuel injection is made to perform at predetermined fuel injection timing when the ignition-delay period of an injection fuel is long, and an engine is a operating range besides said predetermined operating range (it is called a "diffusive-burning operating range" below.). When it is, the ignition-delay period of an injection fuel is considering the compression ignition type internal combustion engine which equips short predetermined fuel injection timing with the fuel-injection control means to which fuel injection is made to carry out as the premise configuration. Operation which sets said diffusive-burning operating range, for example as a heavy load operating range or a high rotation operating range, and makes a subject the same diffusive burning as ordinary Diesel engines is made to perform in this compression ignition engine. Moreover, said premixed fuel operating range is set, for example as a low Naka load or the operating range of a low middle turn, and operation which makes premixed combustion a subject is made to perform in this operating range. Said premixed combustion is a combustion system in which carry out the lag of the fuel injection timing more sharply than the time of performing diffusive-burning operation, carry out the ignition-delay period of an injection fuel by this for a long time than a fuel fuel injection period, and it is made for almost all fuels to burn from a premixing condition, in case these people are the combustion methods proposed in patent the 2864896th grade, perform exhaust air reflux and reduce combustion temperature. Since according to this combustion system the yield of PM (particulate MATA, exhaust air particle) does not increase even if it performs a lot of exhaust air reflux, NOx and PM can be reduced to coincidence.
[0016] In this invention, in such a compression ignition type engine, like the 1st invention, when the activity degree of a catalyst is low, the temperature of reflux exhaust gas is raised and activation of a catalyst is promoted. In addition, an engine service condition is in said premixed combustion operating range, and at least one side of the control which shortens the control or the fuel fuel injection period which lengthens the ignition-delay

period of an injection fuel more at the time of the reflux exhaust gas temperature rise by the reflux exhaust gas temperature control means is performed. If exhaust gas temperature rises, whenever [cylinder internal temperature] will go up with reflux exhaust gas, an ignition-delay period will become short, some injection fuels carry out diffusive burning, and a possibility that a predetermined premixed combustion condition may no longer be acquired is produced. So, in this invention, shortening of an ignition-delay period is compensated and the shape of suitable flammability is made to be acquired by carrying out injection control as mentioned above.

[0017] The control which, on the other hand, lengthens an ignition-delay period which some engines mentioned above at the time of an exhaust gas elevated temperature, or shortens a fuel fuel injection period is insufficient, and some injection fuels may still start diffusive burning. In such a case, as shown as the 3rd invention, it has the inhalation-of-air flow control valve (for example, swirl control valve) which controls an inhalation-of-air flow of an engine combustion chamber, and the inhalation-of-air flow control means which controls said inhalation-of-air flow control valve in the direction in which an inhalation-of-air flow increases at the time of a reflux exhaust gas temperature rise. Since mixing of air and a fuel advances more promptly by strengthening an inhalation-of-air flow in a cylinder, it becomes possible to realize more certainly the premixed combustion condition at the time of an exhaust gas elevated temperature by applying this invention.

[0018] As a catalytic activity degree detection means in each above-mentioned invention, the thing of a configuration of having been shown, for example as the 5th to 7th invention is applicable. That is, in the 5th invention, the activity degree of the catalyst for exhaust gas purification is detected based on the temperature of a catalyst. It becomes possible to judge whether it is necessary to judge whether a catalyst has a catalyst in the condition that necessary conversion efficiency can be demonstrated, by asking for whenever [catalyst temperature] from whenever [representing whenever / actual temperature / of a catalyst /, or this actual temperature / engine cooling water temperature] etc., and comparing this with the predetermined reference value used as an activity degree criterion, since it has the property that temperature rises so that an activity degree increases, namely, to raise reflux exhaust gas temperature.

[0019] Moreover, in the 6th invention, the activity degree of the catalyst for exhaust gas purification is detected based on the temperature and the degradation degree of a catalyst. The conversion efficiency of a catalyst is influenced by the degradation condition, and even if it is the same temperature ambient atmosphere so that degradation of a catalyst advances, conversion efficiency falls. So, in order to judge the activity degree of a catalyst to accuracy more, it is desirable to also detect both the degradation degrees of a catalyst. Although the technique for judging the degradation degree of a catalyst is arbitrary, it can judge, for example from presumption by use elapsed time, the oxygen density comparison before and behind the catalyst under a specific service condition, etc.

[0020] Furthermore, in the 7th invention, the purified matter concentration of a catalyst lower stream of a river is detected, and the activity degree of a catalyst is detected based on

this purified matter concentration. Said purified matter is NOx, HC, CO, etc. Since the condition or the degradation condition that a catalytic activity degree is low is represented also with the concentration of the matter under a certain specific service condition purified [these], it can judge the catalytic activity degree also reflecting a degradation degree by detecting this.

[0021] On the other hand, as a reflux exhaust gas temperature accommodation means in each above-mentioned invention, a configuration as shown, for example as the 8th invention is applicable. That is, it has a reflux exhaust gas cooling means to cool the exhaust gas which circulates the inside of an exhaust air reflux path, and a reflux exhaust gas cooling effectiveness accommodation means to adjust the cooling effectiveness of the exhaust gas by this reflux exhaust gas cooling means. As a reflux exhaust gas cooling means, the water-cooled cooling system which performs heat exchange with exhaust gas with engine cooling water is known.

[0022] Moreover, as a reflux exhaust gas cooling effectiveness accommodation means of the 8th invention, a configuration as shown, for example as the 9th invention is applicable. That is, it constitutes from the 9th invention as a thing equipped with the by-pass control valve which controls the opening of the bypass path which bypasses a reflux exhaust gas cooling means for a reflux exhaust gas cooling effectiveness accommodation means, and passes reflux exhaust gas, and this bypass path. Cooling effectiveness falls and an exhaust-gas temperature rises, so that the flow rate of the exhaust air which passes through a bypass path by the by-pass control valve is increased. Therefore, when the activity degree of a catalyst is low, the exhaust gas temperature which flows into an inhalation-of-air path by increasing whenever [by-pass control valve-opening] is raised, and the purpose of promoting activation of a catalyst can be attained.

[0023]

[Embodiment of the Invention] The operation gestalt which applied this invention to the compression ignition type engine below is explained based on a drawing. While the compression ignition type engine of this operation gestalt performs operation which hits what was explained as the 2nd invention, namely, makes diffusive burning a subject like a common Diesel engine in a heavy load operating range or a high rotation operating range, he performs operation which makes premixed combustion a subject in a low Naka load or a low middle turn operating range.

[0024] drawing 1 -- setting -- 1 -- an engine body and 2 -- a piston and 3 -- for an exhaust valve and 6, as for an inhalation-of-air path and 11, a combustion chamber and 10 are [a crankshaft and 4 / an inlet valve and 5 / the inhalation-of-air collector section and 12] swirl control valves. The inhalation-of-air path of collector 11 lower stream of a river has branched to two paths corresponding to two inlet valves 4, and the swirl control valve 12 changes the strength of the swirl which occurs in a combustion chamber 6 by adjusting the opening of one path of them. 13 is an actuator to which the opening of the swirl control valve 12 is changed in this way, and operates according to the swirl control valve opening control signal from the controller 70 mentioned later.

[0025] It is the catalyst for exhaust gas purification in which 20 was infixed in the flueway and 21 was infixed in the middle of the flueway 20. A catalyst 21 carries out oxidation purification of the HC in exhaust gas at the time beyond predetermined activity temperature. The exhaust air reflux path where 30 opens a flueway 20 and the inhalation-of-air path 10 (collector section 11) for free passage, and 31 are exhaust air reflux control valves to which the opening is changed (respectively henceforth "the EGR path 30" and the "EGR control valve 31"). The EGR control valve 31 receives the EGR control signal from a controller 70, and controls the amount of EGR(s) which flows back from a flueway 20 to a collector 11 through the EGR path 30. The inhalation-of-air throttle valve in which 32 was infixed in the middle of the inhalation-of-air path 10, and 33 are the actuator. The inhalation-of-air throttle valve 32 is reduced if needed, in case the opening performs exhaust air reflux, it reduces the pressure in the collector section 11 by this, and makes reflux of exhaust gas easy. The inhalation-of-air throttle valve actuator 33 carries out the closing motion drive of the inhalation-of-air throttle valve 32 in response to the inhalation-of-air diaphragm control signal from a controller 70.

[0026] 34 is an EGR cooler as a reflux exhaust gas cooling means, and cools the exhaust gas which flows the inside of the EGR path 30 with engine cooling water. The bypass path where the inflow of cooling water of EGR cooler 34, the outflow of cooling water, and 37 bypass EGR cooler 34, and 36 and 37 pass exhaust air, respectively, and 38 are by-pass control valves which adjust the opening of the bypass path 37. The by-pass control valve 38 receives the by-pass control signal from a controller 70, and controls the ratio of the amount of exhaust gas which flows EGR cooler 34, and the amount of exhaust gas which flows the bypass path 37.

[0027] 40 is a fuel injection valve, opens in response to the fuel-injection control signal from a controller 70, and injects a fuel towards the cavity combustion chamber formed in the piston 2. 41-43 are the accumulator (common rail) connected to said fuel injection valve 40, a high-pressure fuel line, and a high-pressure fuel pump, and carry out the pressure up of the fuel from the fuel tank which is not illustrated through these more than an injection pressure. Moreover, 44 is a pressure regulator and carries out metering of the amount of fuel induction of the high-pressure fuel pump 43 in response to the regulator control signal from a controller 70.

[0028] It is the intercooler to which 50 cools a turbosupercharger and 51 cools the pressurization air from a turbosupercharger 50. As for a crank angle sensor and 61, 60 is [an accelerator opening sensor and 62] sensors whenever [engine cooling water temperature]. Moreover, 63 is a fuel pressure sensor and outputs the signal according to the fuel pressure in an accumulator 41. 64 is a sensor whenever [catalyst temperature] and outputs the signal according to the temperature (exhaust gas temperature within a catalyst, or temperature of catalyst support) of the catalyst 21 for exhaust gas purification. 65 is an EGR cooler cooling water temperature sensor, and outputs the signal according to the temperature of the cooling water which circulates the inside of EGR cooler 34. The circulating water temperature in an EGR cooler can be represented with whenever

[engine cooling water temperature], without forming the EGR cooler cooling water temperature sensor 65, when fixed relation is materialized between the circulating water temperature in EGR cooler 34, and whenever [engine cooling water temperature]. 66 is an exhaust gas temperature sensor and outputs the signal according to the temperature of exhaust gas. When exhaust gas temperature can be presumed from an engine service condition or its hysteresis, it is not necessary to form the exhaust gas temperature sensor 66. 67 is a reflux exhaust gas temperature sensor, and outputs the signal according to the temperature of reflux exhaust gas just before flowing back to the inhalation-of-air path 10. The output of each of said sensor is inputted into a controller 70 as a signal showing an engine's various operational status.

[0029] A controller 70 consists of a microcomputer and its peripheral device. It functions as a control means which performs various kinds of signal processing and data processing relevant to this invention. The signal sent from each sensor (60-67) mentioned above is embraced. Namely, fuel oil consumption, Fuel injection timing, target fuel pressure, target EGR control valve opening, target swirl control valve opening, target inhalation-of-air throttle valve opening, and a target bypass ratio are computed, and a control signal is outputted to each actuator (40, 44, 31, 13, 33, 38). It explains referring to the flow chart below drawing 2 etc. hereafter per [which is performed by this controller 70] various kinds of processings. In addition, these processings are periodically performed during engine operation.

[0030] It is a catalytic activity judging routine, and by this routine, drawing 2 judges whether a catalyst is in a predetermined active state based on the temperature and the degradation degree of a catalyst, and at the time with the setting:temperature up demand of the catalyst temperature up demand flag FCAT, 1 and when nothing, it performs 0. Hereafter, order is explained for the step later on.

[0031] Based on the signal from a sensor 64, the temperature CATTMP of the catalyst 21 for exhaust gas purification is read whenever [catalyst temperature] by S101, and the catalyst de-activation index CATREK which subsequently shows the degradation degree of the catalyst 21 for exhaust gas purification from the memory in a controller by S102 is read. CATREK is a value which is computed by the catalyst de-activation detection routine, and is stored in the memory in a controller with a battery back-up (a value is memorized also while operation of an engine is suspended).

[0032] In S103, the catalytic activity judging temperature KASTMP is computed based on the above-mentioned catalyst de-activation index CATREK. The lookup of the value is carried out from the control table which makes it correspond to CATREK and makes KASTMP specifically have memorized. A control table has the property shown in drawing 3 , and, in the time of size, i.e., degradation, advancing [the catalyst de-activation index CATREK], the catalytic activity judging temperature KASTMP becomes high.

[0033] In S104, it judges whether the control for whether the catalyst temperature up demand flag FCAT is 1 and a catalyst temperature up is the midst already performed. In addition, FCAT is initialized by engine starting 1.

[0034] When FCAT is 1, it judges whether CATTMP is [whenever / catalyst temperature] lower than the catalytic activity judging temperature KASTMP at S105. When CATTMP is lower than KASTMP, FCAT is succeedingly set as 1 in S106. On the other hand, when CATTMP is more than KASTMP, FCAT is set as 0 in S107.

[0035] When FCAT is 0 in S104, CATTMP judges whether it is lower than the value which subtracted predetermined hysteresis band H from the catalytic activity judging temperature KASTMP whenever [catalyst temperature] in S108. When CATTMP is lower than said value {KASTMP-H}, FCAT is set as 1 in S109. On the other hand, when CATTMP is said beyond value, FCAT is succeedingly set as 0 in S110.

[0036] Drawing 4 is a target EGR control valve opening calculation routine, and by this routine, it computes target EGR control valve opening TEGR while it judges whether exhaust gas is flowed back based on a load and a rotational frequency in an engine's temperature, a service condition, and this case, and it performs 1 at the time with [of the EGR flag FEGR] setting:EGR, when nothing, 0.

[0037] Based on the signal from a sensor 62, TWN is read [whenever / engine cooling water temperature] whenever [engine cooling water temperature] by S201, and fuel oil consumption Q and the engine rotational frequency NE are read from the memory in a controller by S202. Q is a value which is computed by the fuel-injection control value calculation routine, and is stored in the memory in a controller. NE is a value which is computed by the processing performed whenever the crank angle sensor 60 outputs a predetermined criteria crank angle signal based on the generating time interval of a criteria crank angle signal, and is stored in the memory in a controller.

[0038] In S203, it judges whether TWN is [whenever / engine cooling water temperature] higher than the EGR authorization water temperature EGTWN. This decision is performed in order to forbid EGR at the time between the engine colds which cannot secure operation by which combustion got worse sharply and was stabilized, if EGR is performed.

[0039] In S204, it judges whether the flag FEGCHK which shows the self-test result about an EGR system has any 0, i.e., abnormalities. FEGCHK is a flag set up by the EGR self-diagnostic routine which is not illustrated, and when there are fixing of the EGR control valve 31, an exhaust gas leak from an EGR path system, etc., it is set as 1.

[0040] In S205, it judges whether a current service condition is in a predetermined EGR operating range based on fuel oil consumption Q and the engine rotational frequency NE. It is made to correspond to Q and NE and the lookup of the value is specifically carried out from the control map which makes target EGR rate TEGRR which is the desired value of the ratio of inhalation new air volume and the amount of reflux exhaust gas have memorized, and when TEGRR is larger than 0, it is judged that it is in an EGR operating range. The map of said target EGR rate is illustrated to drawing 5 .

[0041] In S206, when a current service condition is in an EGR operating range, the EGR flag FEGR is set as 0 and the target opening TEGR of the EGR control valve 31 for subsequently realizing target EGR rate TEGRR by S207 is computed.

[0042] When EGR control is forbidden by any of S203 and S204 they are, or when a current

service condition is out of an EGR operating range, the EGR flag FEGR is set as 1 in S208, and, subsequently to 0, i.e., a close by-pass bulb completely, target EGR control valve opening TEGR is carried out in S209.

[0043] In S210, the computed target EGR control valve opening TEGR is stored in the memory in a controller. It is used in the EGR control routine which is not illustrated, namely, the EGR control signal corresponding to TEGR is generated, and TEGR stored in memory is sent to the EGR control valve 31.

[0044] It is a reflux exhaust gas temperature modification decision routine, and by this routine, drawing 6 judges whether control which changes reflux exhaust gas temperature is performed, and at the time with [of the reflux exhaust gas temperature modification flag FEGRH] setting-modification, 1 and when nothing, it performs 0. Moreover, a target bypass ratio is set up.

[0045] Based on the signal from the exhaust gas temperature sensor 66, exhaust gas temperature ExHTMP is read in S301, and the temperature EGCTMP of the cooling water which circulates the inside of EGR cooler 34 is read based on the signal from the EGR cooler cooling water temperature sensor 65.

[0046] In S302, fuel oil consumption Q and the engine rotational frequency NE are read from the memory in a controller.

[0047] In S303, the EGR flag FEGR judges whether it is 0 (=EGR operation). In S304, the catalyst temperature up demand flag FCAT judges whether it is 1 (= those with a demand). In S305, it judges whether it is [current non-idle] under operation based on fuel oil consumption Q and the engine rotational frequency NE. Since temperature of a catalyst 21 cannot be raised from activity temperature even if it changes reflux exhaust gas temperature when it is [super-low load low rotation] under operation like idle operation, modification control of reflux exhaust gas temperature is not performed. In S306, exhaust gas temperature EXHTMP judges whether it is larger than the value which added constant value C to the circulating water temperature EGCTMP in an EGR cooler. When it is EXHTMP>EGCTMP+C, the temperature of reflux exhaust gas rises namely, judges [that temperature modification of reflux exhaust gas can be performed, and] by making EGR cooler 34 bypass and making exhaust gas flow back.

[0048] In S307, while setting the reflux exhaust gas temperature modification flag FEGRH as 1, the target bypass ratio TBR is set up to 100%. In this case, the whole quantity of the exhaust gas flowing back bypasses EGR cooler 34, and flows the bypass path 37.

[0049] When decision [which / of S303-S306] is NO, while setting the reflux exhaust gas temperature modification flag FEGRH as 0 in S308, the target bypass ratio TBR is set up to 0%. In this case, the whole quantity of the exhaust gas flowing back flows EGR cooler 34.

[0050] In S309, the set-up target bypass ratio TBR is stored in the memory in a controller. TBR stored in memory is used by the by-pass control routine which is not illustrated. That is, the by-pass control signal corresponding to TBR is generated, and it is sent to the by-pass control valve 38.

[0051] In addition, although the target bypass ratio TBR is set as 0% or 100% of binary

target, you may make it reflux exhaust gas temperature set up TBR multistage story-wise thru/or in continuation adjustable by this routine, so that only predetermined temperature may rise.

[0052] Drawing 7 is a combustion mode selection routine, it judges whether operation which makes diffusive burning a subject by this routine is performed, or operation which makes premixed combustion a subject is performed, and 0 is performed at the time of 1 and premixed combustion mode at the time of the setting:diffusive-burning mode of the combustion mode flag FHO.

[0053] Based on the signal from a sensor 62, TWN is read [whenever / engine cooling water temperature] whenever [engine cooling water temperature] in S401, and fuel oil consumption Q and the engine rotational frequency NE are read from the memory in a controller in S402.

[0054] A service condition current in S403: Assign the value corresponding to the operating range to which Q and NE belong to the field flag FOPE. The relation between a operating range and Flag FOPE is illustrated to drawing 8 . Here, the property of a operating range shown with each flag is as follows.

[0055] FOPE=0: It is not concerned with the existence of EGR cooler use, but premixed combustion is possible.

[0056] FOPE=1: If an EGR cooler is used, premixed combustion is possible, and premixed combustion is possible, if fuel injection pressure is heightened rather than usual when there is nothing use about an EGR cooler.

[0057] FOPE=2: Premixed combustion is possible if an EGR cooler is used (premixed combustion is not approved without an EGR cooler).

[0058] FOPE=3: It is not concerned with the existence of EGR cooler use, and premixed combustion is not approved.

[0059] In S404, it judges whether TWN is [whenever / engine cooling water temperature] higher than the premixed combustion authorization water temperature HOTWN. In S405, it judges whether the flag FHOCHK which shows the self-test result about a premixed combustion control system is 0 (= normal). FHOCHK is a flag set up by the premixed combustion control self-diagnostic routine which is not illustrated, and when there are fixing of the time of there being abnormalities and failure of an EGR system or the swirl control valve 12, abnormalities, failure of a combustion injection system, etc., it is set as 1 (= prohibition of premixed combustion).

[0060] In S406, it judges whether the reflux exhaust gas temperature modification flag FEGRH is 0 (= with no modification). When FEGRH is 0, it judges whether the field flag FOPE is two or less in S407. When FOPE is two or less, the combustion mode flag FHO is set as 0 (= premixed combustion mode) in S408. When FOPE is 3, the combustion mode flag FHO is set as 1 (= diffusive-burning mode) in S409.

[0061] When FEGRH is 1 in S406, it judges whether the field flag FOPE is one or less in S410. When FOPE is one or less, the combustion mode flag FHO is set as 0 (= premixed combustion mode) in S411. When FOPE is 2 or 3, the combustion mode flag FHO is set as 1

(diffusive-burning mode) in S412.

[0062] Drawing 9 is a target fuel pressure calculation routine. By this routine, first, based on the signal from the reflux exhaust gas temperature sensor 67, reflux exhaust gas temperature RTMP is read and, subsequently fuel oil consumption Q and the engine rotational frequency NE are read from the memory in a controller in S501 S502.

[0063] In S503, criteria reflux exhaust gas temperature STMP is calculated based on fuel oil consumption Q and the engine rotational frequency NE. STMP is the terminal temperature value of the reflux exhaust gas temperature at the time of the usual operation which does not perform modification control of reflux exhaust gas temperature, and is the temperature beforehand searched for by experiment. What is stored in the control map (not shown) made to correspond to Q and NE is read.

[0064] In S504, it judges whether the combustion mode flag FHO is 0 (= premixed combustion mode). At the time of FHO=0, a temperature gradient DTMP is computed by subsequently subtracting actual reflux exhaust gas temperature RTMP from criteria reflux exhaust gas temperature STMP in S505. When modification control of reflux exhaust gas temperature is performed, the value of DTMP turns into a negative value. When the combustion mode flag FHO is not 0, the following processings are bypassed and old TPF is used.

[0065] In S506, the fuel pressure correction value PFHOS is computed based on a temperature gradient DTMP. The lookup of the value is carried out from the control table which makes it correspond to DTMP and makes PFHOS specifically have memorized. Said control table has the property shown in drawing 10 , and the fuel pressure correction value PFHOS serves as size, so that the negative value of a temperature gradient DTMP is size.

[0066] In S507, the target fuel pressure TPF is computed by multiplying the basic value PF 0 of fuel pressure by the fuel pressure correction value PFHOS. A fixed value is sufficient as PF0, and it is good also as setting up according to Q and NE.

[0067] In S508, it judges whether the target fuel pressure TPF is larger than the fuel pressure upper limit MAXPF. When TPF is larger than MAXPF, TPF is restricted to MAXPF in S509.

[0068] In S510, the computed target fuel pressure TPF is stored in the memory in a controller. TPF stored in memory is used by the fuel pressure control routine which is not illustrated. That is, the regulator control signal for bringing the actual fuel pressure PF detected by the fuel pressure sensor 63 close to TPF is generated, and it is sent to a pressure regulator 44.

[0069] The fuel injection timing for making premixed combustion perform is decided on the basis of the condition that reflux exhaust gas temperature is criteria reflux exhaust gas temperature, and in the condition that reflux exhaust gas temperature is higher than criteria reflux exhaust gas temperature, before fuel injection is completed, or before an injection fuel is fully mixed with air, ignition takes place, and possibility that some fuels will carry out diffusive burning becomes high. Since halfway premixed combustion is not desirable on the exhaust air engine performance, it is necessary to enable it to ensure a

premixed combustion subject's combustion also in such a condition. Then, when reflux exhaust gas temperature is higher than criteria reflux exhaust gas temperature, fuel pressure is raised, and he is trying for ignition to take place after fuel-injection termination certainly by shortening a fuel injection period by this routine.

[0070] Moreover, when premixed combustion mode is chosen, he is trying to always amend target fuel pressure by this routine, but as for reflux exhaust gas temperature shifting from criteria reflux exhaust gas temperature greatly, same control is performed even if the time of modification control of reflux exhaust gas temperature being performed is made to amend that it is [under / premixed combustion mode selection and reflux exhaust gas temperature modification control activation / restricting], since it is main.

[0071] Drawing 11 is a target swirl control valve opening calculation routine. By this routine, fuel oil consumption Q and the engine rotational frequency NE are first read from the memory in a controller in S601, and the basic swirl control valve opening S0 is computed S602 based on these fuel oil consumption Q and the engine rotational frequency NE.

[0072] Next, in S603, it judges whether the combustion mode flag FHO is 0 (= premixed combustion mode). In S604, it judges whether the reflux exhaust gas temperature modification flag FEGRH is 1 (= subject to change).

[0073] In S605, the target swirl control valve opening TS is computed by multiplying the basic swirl control valve opening S0 by the swirl control valve opening correction value SHOS. SHOS is less than one fixed value. In addition, according to the temperature gradient DTMP with the criteria of reflux exhaust gas temperature, an adjustable setup of the SHOS may be carried out like the case of fuel pressure amendment. In that case, it is made for the value of SHOS to become small, so that the negative value of DTMP becomes large (however, $0<SHOS<1$). The swirl control valve 12 becomes a closing side, so that TS is small, and the swirl which occurs in a combustion chamber 6 becomes strong.

[0074] When it is NO in decision of S603 and S604 any they are, let basic swirl control valve opening S0 be the target swirl control valve opening TS as it is in S606.

[0075] In S607, the computed target swirl control valve opening TS is stored in the memory in a controller. TS stored in memory is used by the swirl control routine which is not illustrated. That is, the swirl control signal corresponding to TS is generated, and it is sent to the swirl control valve actuator 13.

[0076] The swirl control valve opening in a premixed combustion operating range is decided on the basis of the condition that reflux exhaust gas temperature is criteria reflux exhaust gas temperature, and in the condition that reflux exhaust gas temperature is higher than criteria reflux exhaust gas temperature, before an injection fuel is fully mixed with air, ignition takes place, and possibility that some fuels will carry out diffusive burning becomes high. Then, when reflux exhaust gas temperature is higher than criteria reflux exhaust gas temperature, after it strengthens swirl reinforcement and an injection fuel advances [mixing with air] enough, he is trying for ignition to take place by this routine. When a premixed combustion condition expected only by amendment of fuel

pressure can be secured, it is not necessary to amend swirl control valve opening.

[0077] Drawing 12 is a fuel-injection control value calculation routine. By this routine, first, based on the signal from the accelerator opening sensor 61, the accelerator opening APS is read in S701, and fuel pressure PF is read based on the signal from the fuel pressure sensor 63. Subsequently, the engine rotational frequency NE is read from the memory in a controller in S702.

[0078] In S703, the fuel oil consumption Q for generating required torque is computed based on the accelerator opening APS and the engine rotational frequency NE.

[0079] In S704, it judges whether the combustion mode flag FHO is 0 (premixed combustion mode). When the combustion mode flag FHO is 0, based on fuel oil consumption Q and the engine rotational frequency NE, the fuel injection timing IT for premixed combustion is computed in S705. Fuel injection timing IT is a value which shows the crank angle location which starts fuel injection. IT for premixed combustion is computed as a value by the side of a lag from the top dead center near the piston compression top dead center. Since it will light after an injection fuel will not immediately be lit, but a large ignition-delay period will arise, fuel injection is completed and almost all the injection fuel is mixed with air if fuel injection timing is on a such lag side, the combustion gestalt which makes premixed combustion a subject can be acquired.

[0080] When the combustion mode flag FHO is 1 in decision of S704, based on fuel oil consumption Q and the engine rotational frequency NE, the fuel injection timing IT for diffusive burning is computed in S706. IT for diffusive burning is computed as a value by the side of a tooth lead angle rather than a piston compression top dead center.

[0081] In S707, the valve-opening time amount (fuel fuel injection period) QT of a fuel injection valve 40 is computed based on fuel oil consumption Q and fuel pressure PF.

[0082] In S708, the computed fuel oil consumption Q, the fuel fuel injection period QT, and fuel injection timing IT are stored in the memory in a controller. QT stored in memory and IT are used by the fuel-injection control routine which is not illustrated. That is, when a crank angle is in agreement with IT, sending out of the valve-opening signal to a fuel injection valve 40 is started, and when QT time amount progress is carried out, sending out of a **** signal is ended.

[0083] Drawing 13 is a catalyst de-activation detection routine. By this routine, the temperature CATTMP of the catalyst 21 for exhaust gas purification is first read S801 based on the signal from a sensor 64 whenever [catalyst temperature].

[0084] In S802, the index KAGE which shows the degradation speed of advance is computed based on CATTMP whenever [catalyst temperature]. The lookup of the value is carried out from the control table which makes it correspond to CATTMP and makes KAGE specifically have memorized. This control table has the property shown in drawing 14 , CATTMP is 0 (degradation does not advance) in the range of low-temperature whenever [catalyst temperature], and in the hot range, it serves as size (the degradation speed of advance is quick), so that temperature becomes high.

[0085] In S803, the new catalyst de-activation index CATREK is computed by adding the

index KAGE of the degradation speed of advance to the last calculation value CATREKz of a catalyst de-activation index. In S804, the computed catalyst de-activation index CATREK is stored in the memory in a controller. The memory in this case is the memory by which the battery back-up was carried out, and the contents of storage are held by the dc-battery also during an engine halt.

[0086] it comes out, and it is and this routine is not the thing which presumes degradation degree **** of a catalyst 21 only from temperature hysteresis and by which the technique of degradation detection is restricted to this. Moreover, the degradation speed-of-advance property of drawing 14 is an example, and since all catalysts do not have such a property, it is necessary to check experimentally the property of a control table suitable for the property of the catalyst to be used. Furthermore, when degradation of a catalyst advances under the effect of [other than temperature] of [for lead / the sulfur content in a fuel], for example, effect, it is desirable to compute the catalyst de-activation index CATREK by considering such a property.

[0087] Next, other operation gestalten about the judgment of the activity degree of a catalyst are explained. In this case, as shown in drawing 15 , the HC sensors 68 and 69 are formed in the upstream and the lower stream of a river of the catalyst 21 for exhaust gas purification, respectively. The upper HC sensor 68 sends HC concentration of the exhaust gas with which the down-stream HC sensor 69 flows out of a catalyst 21 the signal according to HC concentration of the exhaust gas which flows into a catalyst 21 to a controller 70, respectively. In addition, when HC concentration in exhaust gas can be presumed from an engine's operational status, the catalyst upstream HC sensor 68 may be omitted.

[0088] Drawing 16 is a routine which judges catalytic activity based on HC concentration before and behind the above-mentioned catalyst. By this routine, based on the signal from the catalyst upstream HC sensor 68, the catalyst upstream HC concentration HCU is first read in S901, and the catalyst down-stream HC concentration HCD is read based on the signal from the catalyst down-stream HC sensor 69.

[0089] In S902, the rate CATACT of HC purification of a catalyst 21 is computed based on the catalyst upstream HC concentration HCU and the catalyst down-stream HC concentration HCD.

[0090] In S903, the existence of whether the catalyst temperature up demand flag FCAT is 1 and a catalyst temperature up demand is judged. When FCAT is 1 here, it judges whether the rate CATACT of HC purification of a catalyst is lower than the rate of catalytic activity judging purification, for example, 50%, at S904. When CATACT is lower than 50%, FCAT is succeedingly set as 1 in S905. On the other hand, when CATACT is 50% or more, FCAT is set as 0 in S906.

[0091] When FCAT is 0 in decision of S903, it judges whether the rate CATACT of HC purification is lower than a value [a little] lower than the previous rate of catalytic activity judging purification, for example, 45%, at S907. When CATACT is lower than 45%, FCAT is set as 1 in S908 here. On the other hand, when CATACT is 45% or more, FCAT is

succeedingly set as 0 in S909.
[0092] Although HC sensor is needed in judgment processing of this catalytic activity, since the activity of a catalyst 21 is judged based on the actual rate of HC purification, the degradation advance condition by ****** and the operating environment of a catalyst sprinkles, and an active state can be more exactly judged to be ****.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The schematic diagram of the mechanical configuration of 1 operation gestalt of the internal combustion engine having the exhaust air reflux equipment by this invention.
[Drawing 2] The flow chart showing the 1st manipulation routine which the above-mentioned internal combustion engine's controller performs.
[Drawing 3] The explanatory view of the catalytic activity judging temperature map used by the manipulation routine of drawing 2 .
[Drawing 4] The flow chart showing the 2nd manipulation routine which the above-mentioned internal combustion engine's controller performs.
[Drawing 5] The explanatory view of the target EGR rate map used by the manipulation routine of drawing 4 .
[Drawing 6] The flow chart showing the 3rd manipulation routine which the above-mentioned internal combustion engine's controller performs.
[Drawing 7] The flow chart showing the 4th manipulation routine which the above-mentioned internal combustion engine's controller performs.
[Drawing 8] The explanatory view of the field flag map used by the manipulation routine of drawing 7 .
[Drawing 9] The flow chart showing the 5th manipulation routine which the above-mentioned internal combustion engine's controller performs.
[Drawing 10] The explanatory view of the fuel pressure correction value map used by the manipulation routine of drawing 9 .
[Drawing 11] The flow chart showing the 6th manipulation routine which the above-mentioned internal combustion engine's controller performs.
[Drawing 12] The flow chart showing the 7th manipulation routine which the above-mentioned internal combustion engine's controller performs.
[Drawing 13] The flow chart showing the 8th manipulation routine which the above-mentioned internal combustion engine's controller performs.
[Drawing 14] The explanatory view showing an example of the catalyst de-activation index map used by the manipulation routine of drawing 13 .
[Drawing 15] The important section block diagram of other operation gestalten about a catalyst de-activation judging.
[Drawing 16] The flow chart showing the manipulation routine which an internal

combustion engine's controller performs based on the configuration of drawing 15 .

[Description of Notations]

1 Engine Body

6 Combustion Chamber

10 Inhalation-of-Air Path

11 Inhalation-of-Air Collector Section

12 Swirl Control Valve (Inhalation-of-Air Flow Control Valve)

20 Flueway

21 Catalyst

30 Exhaust Air Reflux Path

31 Exhaust Air Reflux Control Valve

32 Inhalation-of-Air Throttle Valve

34 EGR Cooler (Reflux Exhaust Gas Cooling Means)

37 Bypass Path

38 By-pass Control Valve

40 Fuel Injection Valve

43 High-Pressure Fuel Pump

44 Pressure Regulator

60 Crank Angle Sensor

61 Accelerator Opening Sensor

62 It is Sensor whenever [Engine Cooling Water Temperature].

63 Fuel Pressure Sensor

64 It is Sensor whenever [Catalyst Temperature].

65 EGR Cooler Cooling Water Temperature Sensor

66 Exhaust Gas Temperature Sensor

68 Catalyst Upstream HC Sensor

69 Catalyst Down-stream HC Sensor

70 Controller 70